Next Generation Air Transportation System Demonstration Program

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What is a demonstration, and why are they important for achieving NGATS goals?

New technologies and methodologies are brought into the National Airspace System (NAS) every day. In many cases, these are part of the normal technology acquisition program for existing surveillance, automation, communication, and navigation systems, and are managed by the appropriate acquisition project office. In other cases, they represent a new generation of a well understood technology – such as radar – and can be directly assigned to an implementation team once the business case has been developed and a capital investment decision has been made. Many of the technologies necessary to achieve NGATS goals, however, do not fall into these categories. The technology itself may be new to air traffic control, the manner in which it can be used as part of the system is not clear, and its acceptance by controllers, pilots and other users is not established. For these transformational technologies, a robust field demonstration is often the only way to address the important questions which must be answered before a new technology can be transitioned into the system.

A new idea presented for inclusion into the NAS as part of the NGATS package will have gone through a period of research and systems analysis (RSA) which will have included university research, simulation and modeling, advanced engineering development, and laboratory testing and demonstration conducted by private

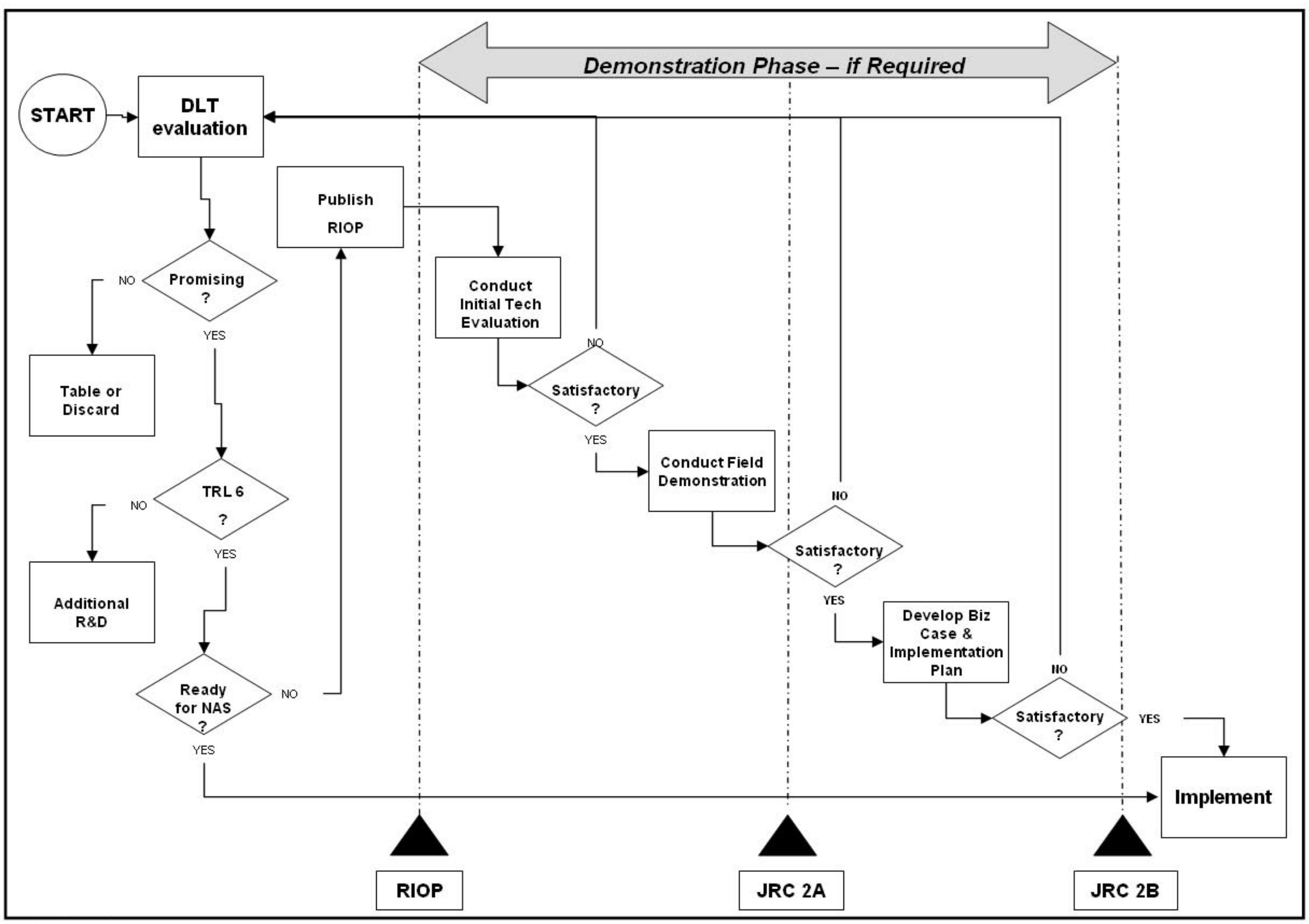

Figure 1 The FAA's NGATS demonstration process

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industry, academic institutions, Federally-Funded R&D Centers (FFRDCs), NASA Centers, or the FAA's William J. Hughes Technical Center. Ideas presented for NGATS inclusion will come in all sizes, from small changes to electronic components – for example, the use of light-emitting diodes (LEDs) in airport lighting fixtures – to sweeping system-wide changes in practice – for example, changing from independent to dependent surveillance as the basis for aircraft location. Some ideas will be developed by small entrepreneurs and will be directed to the FAA through Congressional language. Others will result from research directed by the JPDO to be conducted by the research establishments of the member departments and agencies. Our challenge is to make sense of this array of opportunities and select those with the highest potential for affecting the NGATS transformation.

Table 1. During the demonstration phase itself, concepts selected for demonstration are evaluated using a rigorous three step process

Three Step Evaluation Process for Technology Demonstrations (Performed after the technology has been approved for demonstration through an RIOP, and prior to JRC 2A or equivalent decision point)	
Question Asked	**Significance**
1) Does this technology work the way the proponents claim it does?	Most technologies have enthusiastic proponents, before expending significant resources, it is necessary to confirm the essential technical elements of the idea.
2) Can this technology be made to work effectively in the NAS? In other words, what about: - airspace - procedures - training - controller use/acceptance - pilot use/acceptance - maintenance philosophy/ strategy - logistics - concept of operations - benefit mechanism - avionics equipage - regulatory issues/ NPRM - advisory circulars - RTCA/ICAO standards - Industrial base - Fit with Enterprise Architecture, TSD, and NGATS Portfolio - Competing solutions - Transition strategy	Just because an idea is technically feasible, it may not be appropriate for use in the NAS for a variety of reasons; additionally, there is an interplay among the cost, benefits, and concept of use of a technical idea which must come into balance before it has a good chance of benefiting the system; finally, many of these complexly interwoven questions can only be answered through a field trial in an "actual" operational evaluation, particularly so if the technology in question is transformative or does not involve a simple linear extrapolation of today's system.
3) Is there a business case for this technology?	Given an answer to the questions in step (2), does it make sense for the FAA to invest in this idea from an economic point of view; this analysis must take into account more than just the benefit to cost ratio, but involves trading off the candidate technology against other needs and solutions to maximize the result against overall system metrics

How do we decide which of these many ideas to evaluate?

Our goal is to manage this heterogeneous influx of good ideas of all sizes and levels of maturity so as to provide a continuous stream of improvements into the NAS which are achievable today and which keep us on the path to the future NGATS system. To do so, we use a simple but rigorous methodology which evaluates the risk, utility and cost of each new idea; remains open to new ideas; and moves each idea through an assessment program which minimizes the time spent with the technology and maximizes the likelihood that useful technologies will be deployed to the NAS in a timely fashion.

Since NGATS technology must be implemented in the NAS in order to bear fruit, the place in which the demonstration program is managed is in the FAA Air Traffic Organization, and specifically in the Operations Planning service unit, which executes the demonstration program on behalf of the JPDO. Figure 1 illustrates the overall process, whose first step is the evaluation of a new idea by the Decision Liaison Team (DLT) comprised of representatives from Systems Engineering, Aviation Research and Development, the William J. Hughes Technical Center, and Technology Development. The purpose of this initial review is to determine whether the proposed idea could be on the path to NGATS; has potential technical and operational merit; and to assess its current level of technical maturity. The DLT produces an FAA Acquisition Management System (AMS) document called a Research Investment Opportunity Paper (RIOP), which recommends immediate implementation, additional research, laboratory testing, or a field demonstration. Once a technology reaches NASA Technical Readiness Level (TRL) 6 we are ready to consider how the technology can be used in the system.

If field development and demonstration is recommended, then the idea is incorporated into the technology development and demonstration program. At the present time, each technology under demonstration is separately evaluated and managed, however we are in the process of transitioning to a portfolio management approach in which all the technologies will be evaluated continuously for technical, operational, and economic performance as part of an integrated package.

What are the criteria for entering and exiting the demonstration phase?

Completion of the RIOP starts the demonstration phase, the goal of which is to arrive at a successful initial investment milestone (or termination and send the concept back to the DLT for disposition.) During the demonstration phase, we must answer three questions:

1) Does this technology work the way the proponents claim it does?
2) Can this technology be made to work in the NAS?
3) Is there a business case?

Only when these questions are answered, can we proceed to develop the implementation plan, and prepare for a final FAA capital investment decision. A summary of the demonstration process is shown in Table 1 at above.

Table 2, Part I and Part II. Successful NGATS demonstrations being prepared for initial or final investment decisions in FY'06.

I. Final Investment Decision*. Implementation planning underway – Joint Resource Council decision scheduled.

Program	JRC2B date	What it does
ADS-B National Deployment	July '06	Provides for a national ground station infrastructure and regulatory action in support of transition to dependent surveillance for the NAS
SWIM	July '06	Establishes a net centric information management architecture for the NAS
Capstone Phase III	July '06	Extends safety benefits from WAAS routes, weather infrastructure, and air-to-air ADS-B in Alaska to additional areas in the state
LED airport lighting*		Improves visibility and cost performance of runway and taxiway lighting

* Or publication of an appropriate Advisory Circular for those projects which will be funded through the Airport Improvement Program as opposed to FAA capital funding.

II. Initial Investment Decision. Business Case in Development, Joint Resources Council decision scheduled.

Program	**JRC2A date**	**What it does**
Runway Status Lights	May '06	Provides runway status information to pilots on the ground

During the technology demonstration, we can permit a three way float among requirements, technical specifications, and cost: we can consider not only what technologies can be applied to known shortfalls, but also, how known technologies can be used to improve or extend the Current capabilities; while at the same time, we remain cognizant of the scoping requirement: in other words, given a technology/requirement pair, is the cost of implementation favorable, or can the features of the pairing be adjusted to make it more cost beneficial. At the same time, we have responsibility to develop a business case, determining whether implementation of a given idea will move organizational metrics of operating cost, value to customers, revenue, or safety.

The demonstration process shown in Figure 1 also addresses another problem traditionally faced by the FAA, the timely transition of promising experimental projects from research to implementation. Once a technology has been proven through demonstration, and the relevant questions answered, we need to move to construct a business case and make an implementation decision. Note that establishment of an operational sponsor must be done prior to the Final Investment Decision (JRC2B) and is ideally completed prior to the Initial Investment Decision (JRC2A).

So, what specific demonstrations are currently planned leading up to NGATS?

We envision three waves of technology demonstrations as we move toward 2025. The

Table 3, Parts III and IV. Technologies currently under demonstration or being considered for the demonstration program by the Development Liaison Team.

III. Demonstrations in progress. Technical and operational questions remain to be answered		
Program	**What it does**	**Status**
Capstone Development	Examining a set of future enhancements including satellite comm; multimode sensing; and advanced cockpit avionics	Most in early stages of evaluation
Cockpit Display Assisted Visual Separation§	Allows pilots to extend visual flight rules into marginal weather	UPS has made application to the FAA for an operational waiver to allow further demonstration to proceed
Final Approach Runway Occupancy System¶	Provides runway occupancy information to pilots on final approach	Shadow operations underway at Long Beach, CA
Surface Moving Map	Provides a moving map with own ship position display in the cockpit	Initial demonstration completed successfully; on hold due to funding; part of ADS-B future phase
Multi-Center Traffic Management Advisor (MC-TMA)§	Extends time based metering beyond a single center	Demonstration complete; operational and business case to be completed
Fogeye	Applies UV light detection to runway occupancy	Initial technical evaluation underway at Providence, RI
Runway Occupancy Detection System	Low cost integrated runway safety logic system	Initial technical evaluation underway at Biloxi, MS
Surface Management/Traffic Management Systems§	Provides integrated surface/near surface situational awareness for airport operational efficiency	Systems in use at Memphis, TN and being installed at Louisville, KY; operational and investment case to be made
Low Cost Radar¶	Provides a low cost surface surveillance radar for situational awareness to low traffic volume towers	Competing off-the-shelf systems under initial technical evaluation at Spokane, WA
Ground Marker¶	Uses 75MHz marker channel to provide voice alerts to pilots on the airport surface	Initial technical evaluation unsuccessful; on hold pending decision on redesign

IV. Research Investment Opportunity Papers (RIOP). At or beyond NASA TRL 5, no work is being funded by FAA		
Idea	**What it may do for NGATS**	**Status**
Small Aircraft Transportation System (SATS) products	A basket of technologies designed to improve the capacity of General Aviation; one or more may have a significant benefit to NGATS	Under active evaluation for potential implementation or demonstration in the NAS
Merging and spacing	Uses the CAVS/CEFR concept to close gaps in the arrival stream at an airport; important for 3X capacity challenge; future ADS concept	Proposed by UPS as part of the overall Louisville initiative; under consideration
Global Interoperability	Align initiatives underway in Europe and Asia with NGATS; take advantage of coordinated end-to-end 4D trajectories	Proposed by Boeing; under consideration
Unmanned Aircraft Systems (UASs) in the NAS	Evaluate operation of UASs in the NAS; addresses important new class of vehicles which NGATS must accommodate	Under discussion with stakeholders; potential consideration in FY '06

§ *Operational Evaluation Plan capacity improvement Pilots and Prototypes Ring project*
¶ *Runway Incursion Reduction Program project*

first wave consists of demonstrations already underway, with several nearing completion, and represent critical foundational technologies for the NGATS. These include the initial phase of Automatic Dependent Surveillance – Broadcast (ADS-B), which will introduce dependent surveillance as a future system tool, and System Wide Information Management (SWIM), which will permit network centric operations in the NAS. The status of these near term technologies is summarized in Table 2, Part I, below. Also shown, in Table 2, Part II, is one technology – Runway Status Lights – which, having completed a successful series of demonstrations, is working toward an Initial Investment Decision (JRC2A).

The second wave of demonstrations will include downstream enhancements to the foundational technologies, as well as other concepts and technologies which can be thought of as complementary. These include such things as cockpit applications of dependent surveillance; integration of surface management systems into NAS operations; global harmonization of NGATS technologies; and advanced integrated radar systems. A sampling of these technologies, which are currently part of the demonstration program, is summarized in Table 3, Part III. Additional concepts currently under evaluation by the DLT, for which RIOPs are being considered, are shown in summary form in Table 3, Part IV.

The third wave encompasses technologies which are today in the basic research stage, but which will be required to implement additional NGATS capabilities. These include concepts such as next generation, low cost and high accuracy inertial navigation systems; investigation of innovative radio spectrum utilization schemes; and new safety enhancements in flight and on the surface.

Table 4, Part V. Research initiatives with future demonstration potential for the NGATS.

V. Future Demonstration Candidates. Ideas which are still in research or engineering development		
Idea	**What it could do for NGATS**	**Who's doing the research**
Phased Array Radar	Provides a low cost, multi-mission surveillance and comm platform as a backup to dependent surveillance; next generation Federal weather sensor	William J. Hughes Technical Center; coordinated with other Federal Agencies through the interagency radar replacement working group
Cockpit weather products	Allows air transport pilots to share the same enhanced weather products available to ATC and traffic flow managers	Discussion initiated within FAA; existing research is in weather community
Enhanced inertial navigation	Low cost, high precision, low form factor inertial navigation systems; candidate for use as a second navigation source for dependent surveillance	Office of Naval Research; Defense Advanced Research Projects Agency; discussions and joint evaluation underway
NAS Evaluator	The evaluator is a key concept for the future NAS.	Some initial work is underway at the William J. Hughes Technical Center and elsewhere, but much needs to be done before this concept can be demonstrated.

What challenges does the demonstration program face, and how is it likely to change?

In executing a robust field demonstration program for the NGATS, we face four major hurdles:

First, maintaining our connection to the FAA and JPDO enterprise architectures and the evolving NGATS vision. As the NGATS vision evolves and the FAA's own planning meshes with that vision through the One Plan philosophy, the demonstration plan must remain flexible to ensure that the ideas being demonstrated fit on the path outlined in the planning documents.

Second, by continuing to ensure the deployment of successful technologies into the operational NAS, we are bridging the transition gap. It's important for the demonstration program to avoid the sandbox trap: it does no good to demonstrate ideas which cannot be implemented. Timely and vigorous engagement with operational sponsors should alleviate this danger, but will require continuing effort.

Third, portfolio management provides an essential tool in managing the demonstration program, because it allows all the projects to be assessed as part of a package, rather than piecemeal. The best technology development investment is balanced in terms of technical and operational risk, financial impact, and probability of success and the assessment is continually updated as demonstrations produce additional technical, operational, and economic data. The portfolio management technique permits sophisticated scoping of the development program, ensuring that scarce development resources are expended where the greatest leverage can be achieved, and protecting against investments in technology which outweigh the likely payoff. Exciting developments in the mathematics and processes behind technology portfolio management are underway at MIT and Georgia Tech; these concepts, as well as the concept of Value Driven Design, are under active consideration as we continue to evolve the NGATS demonstration program.

And finally, fourth and perhaps most important, developing additional high quality candidates for demonstration (or immediate implementation) to follow the dependent surveillance and network centric information management building blocks currently nearing investment decisions. Although the list of potential demonstration technologies in Tables 3 and 4 is extensive, it is, with few exceptions, lacking in the kinds of transformational concepts necessary to meet NGATS transformation objectives. We must ask ourselves where are the next ADS-B or SWIM on these lists? While the JPDO is actively directing important research initiatives among the member agencies, research results are likely to be far out in time – too far out to bear fruit in the timeframes required by the NGATS plan. We need to aggressively scout out the big ideas we will need to fuel the next round of transformation: these ideas are most likely out there in the research community today, and they need to be found, evaluated, and brought to a sufficiently high technology maturity level to be assessed for implementation into the system soon.

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Currently assigned as Director of the FAA Air Traffic Organization's Office of Technology Development. He joined the FAA after 23 years at TRW, Inc, from which he retired as Vice President, Aviation Services, in 2001. He holds Bachelor's, Master's, and PhD degrees from the University of Virginia. He is the executive sponsor of the FAA's Center of Excellence in Aviation Operations Research (NEXTOR), an Associate Fellow and member of the Board of Directors of the American Institute of Aeronautics and Astronautics, and a private pilot.